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Electricity in Mining.

PAPER PREPARED BY COL. C. W. JENKS, AND READ AT COLUMBUS MEETING BY MR. MCLAUGHLIN, BOTH OF THE SPRAGUE ELECTRIC RAILWAY AND MOTOR COMPANY.

The practical and economical use of electrical agency in many mining appliances, is a fixed fact.

Brain's electrical method of shot firing and blasting, in the English coal mines, is coming into general use; its success being certified to, most cordially, by all who have adopted it.

Swan's Portable Electric Safety Mining Lamps are making a good reputation for themselves, as are those also, of some other makers.

At the Trafalgar Colliery, Forest of Dean, England, an electrical pumping plant, has been in operation for eighteen months, and is working satisfactorily. The pump and motor are placed in a level, at a distance of about a mile from the bottom of the shaft; and the water is lifted a vertical height of 300 feet to the discharge at the surface, where is located the electric generator, driven by the steam plant.

It has been found in the English Collieries, that an electric plant can be put down economically, and with very great despatch. By former methods, in the use of steam, compressed air or water, it has been generally necessary to place the pipes in ditches, to protect them, and keep them out of the way. With copper conductors for the electric current, no matter how devious the route, or whether the direction be up or down, as many yards of the same, can be put in place in a few hours, as it would require weeks, to place pipes in position; and of course the saving in labor, to say nothing of the advantage in time, is very great.

That a great future is before electricity, in connection with all mining operations, must be perfectly obvious to every intelligent engineer. Enough has been done abroad in coal cutting, to demonstrate that an electric plant affords a most ready means of economically distributing power, for use in and about the Collieries. For haulage, as well as for pumping, there have been some applications made abroad.

Will the system be adopted in this country, especially in that department of mining, that most interests us, that of coal mining in the United States?

It has already found successful introduction and use, in metal mining here.

It was adopted on long distance circuits, of from three to fifteen miles, for pumping and hoisting at the gold placer washings of Big Bend, Butte county, California, in July last, giving an efficiency of sixty-five per cent. at the far end, and with that average result, at twelve points on the line, where branch conductors ran off from the main circuit to motors operating pumps, etc., at those localities.

For many months at the Veteran Tunnel, at Aspen, Colorado, it has been operating incline and direct hoists; and doing effective underground and surface haulage; primal energy being a waterfall one and one half miles away; while also, preparations are now nearly completed for its further extended use, for similiar purposes, at the Regent Mine, in the same locality.

The most recent application, is that seen at the Drain Colliery, Osceola, Clearfield county, Pennsylvania, where is placed an electric motor for the operation of a coal cutter, of the type and patent known as a "Lechner Hercules."

In the installation mentioned, a ten horse-power motor is mounted on a truck, on the mine tramway; and as the motor weighs less than 1000 pounds, it is easily moved as the occasion requires. The Lechner machine is set in position in the room to be cleared, the motor is moved near it, and held in place by stay guys. The motor is then connected with the cutter by a tarred hemp rope, running in V-shaped, grooved sheaves, on the motor and cutter. The connection is of sufficient length, so as that the motor can be operated thirty feet from the cutter. The dynamo, that generates the current, is at present 1600 feet away from the motor it is driving.

By means of suitable jacks, carrying pulleys, the cutter can be operated from any angle from the motor, the connection being made taut by a movement of the motor truck to the needed position.

The installation of motor and cutter has been found to work with ease, giving perfect satisfaction to the mine-owners. But two men are needed to operate it, and these two men are excavating 100 tons, each ten hours. These two men require no additional aid in moving the machine to any new position.

Seventy per cent. of the primal energy is given off for work, from motor pulleys to the cutter.

The cost of the electrical equipment for this service, including generator, conductors and motor was \$1,600, and the mine-owner is more than satisfied with his investment.

This application in coal-cutting, with all the others we have mentioned as installed in the United States, have been made by the Sprague Electric Railway and Motor Company, now well known to the public here and abroad for their motors, which are so extensively used in stationary and railway service, and for all classes of mining machinery.

Electric transmission of power has brought to the coal miner especially—from his ability to furnish cheap primal energy—very great additional facilities in his mining work.

The Sprague Motor Company are making motor applications to all classes of mining machinery, and giving the widest and most economical distribution of power for all uses, where hand labor, steam, or any other form of energy has been applied heretofore.

They solicit the presentation to them, for solution, of any and all problems looking to more efficiency and economy in all mining operations.

This paper was prepared by Mr. C. W. Jenks, who is at the head of the mining department of the Sprague Company, and I have had this in my possession for some time. A couple of weeks ago I was in New York, and I told Mr. Jenks that I would like to have something a little more general. While this is all that can be said now on the application of electricity to mining work, still there is a great deal that can be said on the application of electricity to almost everything else, and if it can do satisfactory service in all of the many things to which it has been applied, there is no reason why it cannot do it in this. So I asked him to give me a supplementary paper, which he did, and that I will read now with your permission. This, of course, is intended to be more general.

[At this point Mr. McLaughlin read the supplementary paper, after the reading of which he continued, as follows:]

Mr. McLaughlin: Mr. President and gentlemen. I may say before commencing the reading of this paper, that the subject in which you are specially interested in regard to the application of it to coal mining, we can not give you as much of the reality as we would like. Of course, the electric motor is a recent thing, and every thing can not be accomplished in a day, but that it has made more advancement in the same time, than any motor heretofore has done, I think will be acknowledged by all.

Now, to summarize, what can be done by the electric current in the mine? There is first the application of the electric current for haulage purposes; second, for pumping and ventilation; third, for cutting and drilling; and fourth, in lighting the mines. The mines can be lighted as bright as day at a very little expense. You would be surprised, and the business of mining is made rather a luxury than otherwise. You will be surprised to know how much better it seems down there when it is lighted up as nice as a room, and you can have electric signalling by having a complete method of electric bells. In other words you can do everything with a complete electric plant and central station, you can do everything that you are required to do around the mines and you can easily see that that has a great many advantages.* Now I am here pre-

pared to answer any questions that you gentlemen may ask, and I simply want to define my position. I do not pretend to be a flowery exlectrician, but my connection with the different Edison companies, the organization of them, and operation of them after they were organized, and in the power business, which is a part of the business of any lighting company and the sale of power, I probably have put on sale and started as many motors as any person west of the Alleghany mountains, and it is that experience which enables me to say some things and say them with authority. I have made the application of the motor to a very great many industries. In Detroit where I was connected as manager of the Edison station, after having organized it, I sold and put in operation there a large number of motors, about forty or fifty applied to all kinds of work. I have a paper in my pocket, the Detroit Tribune, which is printed now and has been for the last eighteen months by electricity. The motors I induced them to take at first, they were very reluctant to take. They said we have to make a metropolitan newspaper and we can not be delayed fifteen minutes. Our papers must go out on the train and we have to have a perfectly reliable power. Well we put the power in there and from the time that the power was put in and started, although they have an engine which at first they did not cover, although it is now covered with canvas, they have never had to use the engine, and never have been disturbed or hindered a moment for the want of power from the time we put that in. The same experience is that of every one where they are using the power. We are running to-day, shoe factories, foundries, printing presses, elevators, both hydraulic and direct gear. In Laramie, Wyoming, they are running a grist mill, using two twenty-five horsepower motors for milling purposes. As fast as people can be made to see the advantages, they are making changes, and in almost all of these changes that I refer to, something had to give way—something had to get out of the way—a gas engine, or steam engine, or something. Very few of these cases were original cases—that is, where the person was looking for power, and we put them in power in the first instance. I would be pleased to answer any questions.

DISCUSSION OF MR. JENKS' PAPER.

The Chair: Giving Mr. McLaughlin a little rest to get ready for the attack that will be made on him in a few minutes, I will read an article from Mr. Jenks, which he sent me a day or two ago, in regard to the electric plant.

[The Chair here read the article from Mr. Jenks, and also the letter from Mr. Jenks].

The Chair: Mr. McLaughlin will now be glad to answer any questions which the members may desire to ask him.

Mr. Crafts: I would like to ask, with a 200 volt current and the conditions of insulation that would ordinarily exist or that could be used in a wet mine, what percentage of effective power could be delivered, say, at a distance of half a mile?

Mr. McLaughlin: We would not put any insulation at all on the conductors going into the mines; it is not necessary. The current being perfectly safe, there is no necessity of insulation on that account, and the air itself is the insulator any how, and it has got to be so wet as to be water almost, in order to cause any perceptible loss of current, and the loss of current in the conductor itself, we determine that usually at about ten per cent and it can be made more or less as you put in more or less copper in your wires. An allowance of ten per cent would be reasonable. Does that answer your question?

Mr. Crafts: Yes, sir.

Mr. McLaughlin: I want to state that we have closed a contract with the Ellsworth & Morris Coal Company for putting in an electric plant at one of their mines. We refer here as a matter of history to the fact that the application of our motors had already been made to a machine known as the Lechner Hercules. We have the drawings of the machine made here in Columbus by Mr. Jeffrey. I say we are going to and I mean we are going to. We are going to apply it to that machine, and we will have that application made in a short time, and when the application of the motor to that mining machine is made there is nothing then to stand in the way of the introduction in all of these fields that I have spoken of. There is no trouble about applying it to the drill and for haulage purposes, pumping purposes and ventilation. There is absolutely no trouble about that, and if a mining company were in shape to talk about or negotiate for a plant for hauling purposes we are not in any position to delay on that; we are ready, and for coal cutting of course we will wait until this application has been perfected, but we have not the slightest question in regard to its success, not the slightest. The progress that has been made in the introduction of electricity in various forms is simply wonderful. Now I take something of a pride in the organization of the Edison Company in this city, and I had to carry a lamp down here only two years ago. I had to carry an incandescent lamp here to explain what it was, and now you have one of the finest Edison companies in the country. You go into some places, of course there has been a great deal learned in the last few years, on this subject, but you can go into some places yet where you have to take a lamp to explain what it is. It seems almost incredulous that the advancement should be made so rapidly, but it is. It goes.

Mr. Wheeler: Do you say that a current of 200 volts is en-

tirely harmless? At what point does it become hurtful or dangerous to human beings?

Mr. McLaughlin: Well that is a question that is not settled yet, but there is unanimity in regard to this much, that a current below five hundred volts is safe, and that a current above a thousand is dangerous, especially if that current is received through the vital organs, as for instance you make the connection with your hands and the current was to go through your chest and lungs. A current of 1000 volts is generally considered a very good thing to let alone, but a current below 500 is not considered dangerous, and just how far you can go up between 500 and 1000 is not intirely clear. I think that the current that they have selected to inflict the death penalty in New York is less than a thousand volts. Do you know about that Professor?

Prof. Thomas: The limit is not fixed.

Mr. McLaughlin: I think they expect to do the work with less than 1,000 volts, but up to 500 is now considered safe.

Mr. Crafts: I would like to ask as to the comparative economy in using a 200 volt current, or a higher current which would be within the limit of danger.

Mr. McLaughlin: There is no difference in the economy. The economy would be the same if you used the same kind of a current. That is what we call the constant potential current. Of course you make your economy just what you want it to be.

Mr. Crafts: There would be nothing gained in the percentage of loss in transmission for a long distance by having a higher voltage.

Mr. McLaughlin: You would save wire, of course. To convey electricity with low tension you must have larger wires for the same horse power than with high tension.

Mr. Brooks: I would like to know the size of wire to carry the electricity running one of these large machines. I have heard of a case out West where they used the three-quarter inch wire, and they claimed they could not carry enough on that to make it work effectively.

Mr. McLaughlin: Well, of course, it is impossible to answer the question as to how large a wire it would take to run a certain horse power machine. You have to know more about it. You have to know the distance to which you have to convey it, and the voltage you are going to use. If you use a 200 volt current, and carry it a mile or something like that, then the calculation could be made exactly, so as to tell precisely what would be required. That I could not give now, but the wire would be a very small wire, probably about a No. 6 or No. 8 wire, which is smaller than a lead pencil. The wire that we use for street car purposes is No. 6, and we feed into that with other wires, what we call reinforcing or supplementary wires; but to operate ten cars, ten electric cars,

they ought to have fifteen horse power on; it would require, as I understand it from those who figure on doing the work, that with a single circuit it requires a two naught wire, and a two naught wire is a little over a quarter of an inch in diameter—that is to run ten cars; that is something like 100 horse power.

Mr. Wheeler: Do you say it would not be necessary to have insulation in the mines.

Mr. McLaughlin: I would not have any insulation at all: that is, I refer now to the conductors that are brought in for your tramway work. You bring the conductors right down into the mine. You insulate them, of course, from the ground and from the roof, where you fasten them up by porcelain insulators. But to insulate the wire itself, you do not do that at all. Of course, where you take off a connection from your current for a mining machine, you would use an insulated wire, and let it lie right on the bottom of the mine. Suppose your main entry has a conductor in it, and then in any room, fifty or a thousand feet off you want a current for a mining machine, you take that in with a cable, and run your cable right along on the ground, and pay no attention to it, and you do not lose your current. The insulation is to prevent you from losing your current. Then when you bring your machine out of that room and put it in some other room, you roll that up on a reel, and make your connection at some other convenient point. Do you understand what I mean by that? If you do not, I will show it on the board there.

[Mr. McLaughlin here explained his meaning by a diagram on the board.]

Mr. Hanlon: Is it necessary to have a double wire to complete the circuit?

Mr. McLaughlin: No, it is not necessary to have two wires to run the cars or to do the work. It is not necessary to have any but one wire because the rails are used as a return circuit. To summarize the work of the electric current we have these divisions:

1. Haulage.
2. Pumping and ventilation.
3. Coal cutting and drilling.
4. Lighting.
5. Signal bells.

That covers about everything that you want to do.

Mr. Haseltine: You spoke about 200 volts being harmless and not requiring to be insulated. How many volts do you calculate it will require to put in operation the plant that you are now erecting for Ellsworth & Morris, at their mine in the Hocking Valley?

Mr. McLaughlin: 200; that is what we use. Let me illustrate from the board.

[Mr. McLaughlin then placed the following diagram on the board]

Ampere X volts — Watts.

Ampere represents quantity, and volts intensity, and the product of amperes into volts gives you watts, that is horse power. 746 watts is equal to a horse power. Now that part remains fixed (referring to volts) we will say at 200 or 220 or 230, or somewhere along there. Now it stays at that whether you have ten horse power or fifty. Of course with that stationary this (referring to ampere) must increase; that is quantity, and that is harmless. There is nothing about that that is dangerous. So that the ampere will increase and the volts remain stationary. The ampere increases for each additional horse power you add.

Mr. Haseltine: How much horse power do you estimate it will require to operate that plant?

Mr. McLaughlin: We are putting in a 250 horse power engine there. I do not think it will require quite that much.

Mr. Haseltine: What I was trying to arrive at, is how much horse-power of electricity you expect to be able to apply at various portions of the mine?

Mr. McLaughlin: Well, we are putting fifteen horse-power on each mining machine. We are putting in six mining machines.

Mr. Haseltine: Well, now, will the electricity in this fifteen horse-power engine, transmitted by means of this wire to these six machines be a wire that it would be safe to come in contact with?

Mr. McLaughlin: Perfectly safe, sir.

Mr. Haseltine: And not require enough electricity to operate the six machines to make it dangerous?

Mr. McLaughlin: It does not make any difference how many machines; it does not raise it. We start with a safe current and it does not make any difference how many machines you add, it does not change the character of the current: it does not change the voltage at all. In regard to the application of electricity to mining, if there is as much advancement made in that this coming year as there is in its application to railroads the last year, there will be a good deal done. The Sprague Company started a road at Richmond on the second day of February; that is the first road of any consequence that was put in by them, or any one else in this country. That is a large road; a road using or operating a large number of cars. Since that time, the company have put in, or are putting in some thirty roads, thirty electric roads. Two of them are here right close by; one at Akron, the other at Cleveland. Both are running splendidly. I came from Cleveland to-day, and had a talk with President Everett (?) of the East Cleveland Railroad Company, and he said that he was highly satisfied with the work of the road, and was only waiting for permission from the council to do more. I saw cars running there at the rate of fifteen miles an hour as nice as

you ever saw cars run in your life. It is certainly a great thing. It is near by and you can satisfy yourselves at very little expense.

The Chair: What effect would it have on watches, these street railroads?

Mr. McLaughlin: Well, I do not know; it would affect a poor one, but a good one it will not bother much. That is a fact. I suppose the good one has better springs, and is less affected on that account.

Prof. Thomas: I came in this evening to learn what is being done, and not to talk on this subject, for it is a subject on which a great deal can be said, and would take much more time than is available this evening. I have been very much interested in what Mr. McLaughlin has told us about the workings of the Sprague Company in the development of their business in regard to its application to the mining industry. Those who have paid much attention to the subject, do not need to be told that the electric motor can be used to drive any sort of a machine, that any motor can be used to drive, and it will drive some machines that other motors will not drive. So as regards its fitness for driving any kind of mining machinery, or doing any work about the mines, no one, who has to use such power, need hesitate a moment to apply it to that purpose. The facts, which are now matters of common report concerning the reliability of the work of motors, in the running of different railroads, street railway companies—the Richmond in particular, and the Cleveland and Akron, as I have heard reports of them, show that in cases in which the requirements are much more exacting than in mining operations, these motors have been found to satisfy all requirements.

I am very glad to be able to say from personal study of these machines, the Sprague motors, as well as from reports, that the motors are most excellent electrical machines. Indeed I know of no better motor to-day than the Sprague motor, either as regards its mechanical workmanship, its purpose as an electrical machine, or its durability. I do not mean to say by this the Sprague motor is the best; I say I know of no better. There are other motors which are also good. What you have heard to-night has been concerning the Sprague motor, and I can endorse most heartily that statement that the Sprague system is a reliable system, and the fact that that Company has been able to set in operation and maintain such a system as that at Richmond, and such a system as the one at Cleveland, shows that they are in shape to give business satisfaction to parties who want such work done. The same can be said of some other companies, but perhaps the Sprague has a greater aggregate horse power in operation than any other company. During last summer I was at the Brush Company's works at Cleveland, and saw some large motors built for mining purposes in California. They were to deliver, I think,

something like two hundred horse power. They were built mounted on the same base with Turbine wheels which were to be used in connection with water power. I do not remember the locality to which they were to go.

The question as to the safety to a person of the use of electrical currents in power transmission, is one that has been discussed a great deal, and about which a great deal of needless anxiety has been felt. There is no question, as Mr. McLaughlin states, that a current of less than 500 volts electro motive force is not liable to do serious injury to any person who comes in contact with it. The question as to where the limit of danger does lie is one that is open to discussion, and one which varies a great deal with the person. I have very good reason to believe that a man in the employ of the Columbus Electric Light and Power Company has received the full current from a machine representing 2500 volts, and within an hour and a half from the time that he received that shock he was found by the manager, not under the care of a physician, but was found playing his game of pool. That does not show, however, that a machine affording a current of 2500 volts is a safe machine, for it is well known that persons in our State have been killed with a current of lower potential than that. The question of what is fatal potential depends upon the person who receives it, and the character of the system which gives that potential. But whatever be the fatal voltage, whatever be the merits of the discussion in a business or scientific point of view, there is no question but a voltage below 500 is safe. The question as to what the conditions of a circuit are which carry currents of different powers were very clearly brought out. I wish to add simply a few words. With the efficiencies which are now realized in working machines it is convenient to calculate on a current voltage, etc., required for giving power an allowance of 1000 watts per horse power. A watt, as stated, is the product of the volt by the ampere. To speak a little more familiarly, is equivalent to the head of water in milling, or about a cell in telegraphic offices, that little jar, one of those cells, gives just about what we call one volt, electrical pressure, and 200 volts used in this system would be about the same as that which you get at the end of 200 such telegraphic cells connected. An ampere is the unit of current strength, and corresponds to the fall of water in gallons per minute. Of course we understand that electricity is not something which can be measured by the gallon, but in the effect it produces in certain ways. This ampere is a little less than the current required to light two of the Edison lamps of the most recent form. It will not be out of the way to say that there are in operation in Columbus, here, a considerable number of the Sprague motors of which you have heard so much, and other motors of the Eddy which is of constant potential and of the Brush type in use by the arc light cir-

cuit which is a constant type, and those who have not seen these would be very much interested I think in seeing some of these machines in operation so as to see what the Sprague motor is really like, and I am very sure I shall not incur the enmity of the managers at either of the electric light stations in saying that you will be very welcome in seeing these in operation. After the kindly expression of interest this afternoon as to the short mining course at the University it will not be out of the way to say these very matters we are now speaking of are not lost sight of in that course. Professor Lord has requested me, when the proper point is reached in that course, to give them some instructions in this matter and you may say to any that are interested in such things, that those who pursue that course will have such training and such practice.

The Secretary: Mr. President, I move that a vote of thanks of the Ohio Institute of Mining Engineers be tendered to the Sprague Motor Company, Mr. C. W. Jenks, and Mr. McLaughlin for the very interesting paper they have furnished us to-night.

The motion, being seconded by Mr. Haseltine, then prevailed.